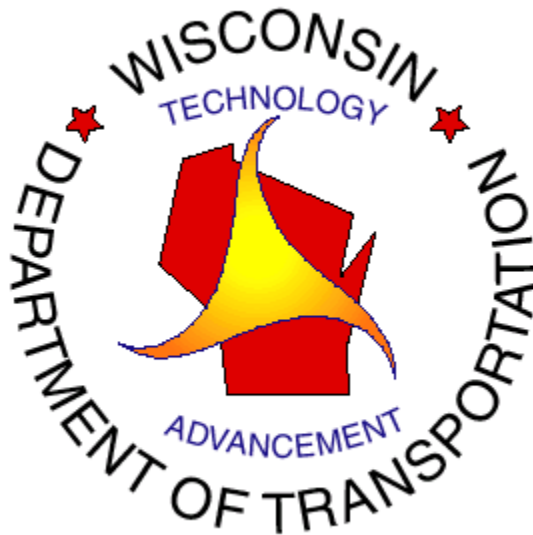


REPORT NUMBER: WI-06-03

Evaluation of Polymer for Soil Stabilization
Natural Earth Poly Stable Plus

FINAL REPORT



August 2003

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16. Abstract Based upon field site inspection, toxicity testing and simulated rainfall tests it was determined that the soil polymer product performed within established guidelines. There was an 87% reduction in rilling at the 10 foot point, and 100% on the upper +/- 80% of the slope. With the cost of soil stabilizers averaging 10% of the cost of installed erosion mat, these products are extremely cost effective. The WisDOT Product Acceptability List (PAL) Committee approved the product at it's May 1, 2003 meeting.					
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Evaluation of Polymer for Soil Stabilization
Natural Earth Poly Stable Plus

FINAL REPORT NUMBER: WI-06-03

by

Gil Layton
Chairperson,
WisDOT Erosion Control & Storm Water Committee

for

WISCONSIN DEPARTMENT OF TRANSPORTATION
DIVISION OF TRANSPORTATION INFRASTRUCTURE DEVELOPMENT
BUREAU OF HIGHWAY CONSTRUCTION
PAVEMENTS SECTION
TECHNOLOGY ADVANCEMENT UNIT
3502 KINSMAN BLVD., MADISON, WI 53704-2507

August 2003

The Technology Advancement Unit of the Division of Transportation Infrastructure Development, Bureau of Highway Construction, conducts and manages the highway technology advancement program of the Wisconsin Department of Transportation. The Federal Highway Administration provides financial and technical assistance for these activities, including review and approval of publications. This publication does not endorse or approve any commercial product even though trade names may be cited, does not necessarily reflect official views or policies of the agency, and does not constitute a standard, specification or regulation

Table of Contents

<u>Section</u>	<u>Page</u>
Technical Documentation page.....	i
Title Page	ii
Table of Contents	iii
Background	1
Toxicity	1
Test Site.....	1
Installation.....	2
Monitoring	3
Conclusion	4
Implementation	4
References	5
Appendix A : Use Restriction	6

<u>Figures</u>	
Figure 1 Installation	2
Figure 2 Control	3
Figure 3 Comparison.....	4

New Product Field Test
Natural Earth Poly Stable Plus
(Soil Stabilizer, Type B)
Manufactured by Earth and Road
Nov. 2002 – May 2003

BACKGROUND

The Wisconsin Department of Transportation requires that erosion and sediment retention products be pre-approved on the departments Erosion Control Product Acceptability List (PAL). This product completed the prerequisites for a field performance test as prescribed in the PAL.

The category of Soil Stabilizer Type B requires that products have a toxicity test done by an approved laboratory, and be issued a use restriction by the Wisconsin Department of Natural Resources. The Wisconsin State Laboratory of Hygiene conducted the toxicity test

As a pre-qualification for field performance testing a rainfall simulator test, done by an independent laboratory, is also required. Aicardo Roa, Ph.D. conducted the rainfall simulator test at the University of Wisconsin.

TOXICITY

The base material of this product is a natural chitosan polymer, manufactured from sea shells. Toxicity test results indicate that chitosan based polymers may be applied at much higher rates than synthetic based polyacrylamide products. The toxicity evaluation by the Wisconsin DNR gave the manufacturer a use restriction of 26.8 pounds per acre. The manufacturer recommends a maximum effective application rate of 20 pounds per acre. Given that the use restriction is based on a 10 fold margin of safety, the manufacturers recommended application rate is 75% of the use restriction or 7.5% of the actual toxicity threshold.

TEST SITE

WisDOT test protocol requires the product to be installed on a minimum slope of 2 ½ : 1, which is at least 50 feet in length. It also requires that the product be installed between November 1st and December 1st of any given year, with the evaluation done through the ensuing winter and spring months, and until such time as permanent vegetation is established. Testing during normal growing season months often produces vegetation, prior to getting significant rains and accompanying rilling, which makes product evaluation difficult if not impossible. Spreading the evaluation over a longer period also makes for more uniform testing, from product to product, and from year to year. It also reflects WisDOT's reliance on this type of product to help stabilize slopes through the winter months where they have been shaped too late in the season to establish vegetation.

The Marshfield Wisconsin area has very heavy clay soils susceptible to rilling. The contractor, for several WisDOT projects in the area, had just done some work for the Marshfield Super Speedway and suggested that we consider that for a test location. Since the site is fenced it provided better security against snowmobile or ATV damage. The slope selected was 52.5 feet in length, with a 2 ½ : 1 slope, and is intended as an overflow seating area adjacent to their grandstand seating area.

INSTALLATION

The area was topsoiled on November 7, 2002 and the installation of the test plots was done on November 8, 2002. Two 20 feet wide test plots were marked off across the slope. One section was a control section with only seed applied, and the other section was the test section with seed, lime, and polymer applied. Prior to installation the owner dragged the entire area with a weighted steel mat to smooth the topsoil.

Temporary seed (winter wheat) as well as a permanent turf grass seed mix was applied to the entire site. Polymer was applied to the test section using a small 75 gallon hydro sprayer. Slightly less than ½ pound of polymer was mixed with water and applied to the slope. 100 pounds of agricultural limestone was applied to the test section only to increase the ph of the native soils.

The weather conditions at the time of installation were partly cloudy with a temperature of 56 degrees Fahrenheit. Installation was completed between the hours of 4 to 6 PM, with the track lighting being used to finish up.



Figure 1: Installation photo: foreground section (between lath) shows control section, and background section shows the test section.

MONITORING

Monitoring was done by department personnel by field inspections. The following is the log of those visits;

11-27-02 , very minor rilling on control section was evident after two <1/2 inch rainfalls.

12-27-02, heavy rain had fallen on 12-18-02 over frozen ground, no visual change.
Light snow cover on all but the top 5 to 6 feet of the slope.

3-26-03, site was visited after the spring snow melt. Minor (1/4 inch deep X 2 inch wide) rilling was noted on control section, with none on the test section.

4-10-03, Rilling was becoming much more evident on the control section after recent heavy rains. Counted 15 rills on the control section and 1 on the test section, measured 10 feet up from the bottom of the slope.

4-23-03, There had been very heavy rainfall over the previous week, with water standing everywhere and streams overflowing their banks. Counted 23 rills across the control section and 3 across the test section, measured 10 feet up from the bottom of the slope. The test plot rills did not extend more than 12 feet up the slope, but the control section had rills extending to the top of the slope. This was an 87% reduction in rilling at the 10 foot point, and 100% on the upper +/- 80% of the slope. Grass is just beginning to come up uniformly across both the control and test sections.



Figure 2: Photo shows rilling evidenced on control section.

5-11-03, The site had additional heavy rain. Rilling is about the same, but the vegetation is noticeably worse on the control section, probably due to seed washing down slope.

6-17-03, A final site visit was done to check vegetation. Permanent seed has germinated, and the owner has mowed the site. Overall the test section looked significantly better than the control section.



Figure 3: shows minimal rilling on test section. Note, for purposes of determining the line between the sections, the white streak is lime residue, and covers approximately the left 40% of the test section. The control section (previous photo) is immediately left of the white streak.

CONCLUSION

Based upon the April 23, 2003 site inspection it was determined that the product performed within established guidelines. There was an 87% reduction in rilling at the 10 foot point, and 100% on the upper +/- 80% of the slope. With the cost of soil stabilizers averaging 10% of the cost of installed erosion mat, these products are extremely cost effective.

IMPLEMENTATION

The WisDOT Product Acceptability List (PAL) Committee approved the product at it's May 1, 2003 meeting.

REFERENCES

Link the Wisconsin Land and Water Conservation Association technical standard for “Erosion Control-Land Application of Anionic Polyacrylamide” at;

<http://efotg.nrcs.usda.gov/popmenu3FS.aspx?Fips=55025&MenuName=menuWL.zip>

Link the WisDOT PAL at;

<http://www.dot.wisconsin.gov/business/engrserv/pal.htm>



DANE COUNTY LAND CONSERVATION DEPARTMENT

FEN OAK RESOURCE CENTER
1 Fen Oak Ct., Rm. 208, Madison, Wisconsin 53718-8812
PH: 608/224-3730. FAX: 608/224-3745

DATE: August 02, 2002

TO: Derek Hoffman
Earth and Road

FROM: Aicardo Roa, Ph.D.
Urban Conservationist, Dane County Land Conservation Department
Assistant Visiting Professor, Biological Systems Engineering, University of Wisconsin-Madison

RE: **RAINFALL SIMULATOR TEST**

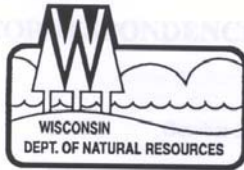
The following are the result of the rainfall simulator on natural "NATURAL EARTH POLYSTABLE PLUS".

Fifteen small bare plots (1 meter x 1 meter) on a 10% slope were analyzed for runoff and sediment yield on a construction site. A rainfall simulator applied 6.32 centimeters of rainfall per hour to each plot after a polyacrylamide mix ("NATURAL EARTH POLYSTABLE PLUS") treatment was applied. The following treatments: No PAM mix applied to dry soil (control), PAM-mix in solution applied to dry soil, dry PAM mix application to dry soil, PAM mix in solution with mulch/seeding applied to dry soil, and PAM-mix in solution applied to moist soil. Each treatment was repeated on three plots. When a solution of PAM-mix with mulch/seeding was applied to dry soil and compared with the control (no PAM-mix application to dry soil), we found an average reduction of 93% in sediment yield. An average reduction of 77% in sediment yield was the worst performing PAM treatment, and occurred when PAM-mix in solution was applied to moist soil. The application of dry PAM-mix to dry soil reduced sediment by 83% and decreased runoff by 16% when compared to the control. Our results show that regardless of the application method, PAM-mix was effective in reducing sediment yield in the test plots. The ease of application, low maintenance, and relatively low cost associated with PAM make it a practical solution to the costly methods being implemented today.

The objectives of this study are to determine the optimum application methods and the effectiveness of the "Natural Earth Poly-stable Plus". The PAM-mix was tested under moist and dry soil conditions. The different application methods were applied to a construction site in Verona site. Data were collected to determine the most effective method of application and the effectiveness of the PAM-mix on construction sites.

CONCLUSION

Our results show that, regardless of the application method, PAM-mix was effective in reducing sediment yield in the test plots. The most effective method of soil treatment throughout this study in reducing sediment yield is PAM-mix in solution with mulch/seeding applied to dry soil. The ease of application, low maintenance, and relatively low cost associated with PAM-mix makes it a practical solution to costly existing methods being implemented. The evidence from the field application in this study reflects that PAM-mix is a tool to reduce soil loss on bare soil until vegetation cover is established.



State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Scott McCallum, Governor
Darrell Bazzell, Secretary

101 S. Webster St.
Box 7921
Madison, Wisconsin 53707-7921
Telephone 608-266-2621
FAX 608-267-3579
TTY 608-267-6897

November 6, 2002

Derek Hoffman
Earth & Road Corporation
N4571 Circle Dr.
Cambridge, WI 53523

Subject: Natural Earth Poly-Stable Plus

Dear Mr. Hoffman:

By copy of this letter I am forwarding the analysis completed by Mike Wenholz for the Natural Earth Poly-Stable Plus. Mike reviewed, under s. NR 106.10, Wis. Adm. Code, the toxicological data submitted by you to develop a use restriction for your product. The use restriction identifies the concentration below which the product is not expected to cause acute toxicity in the aquatic environment.

As you know, the Department, along with a team of technical experts, has developed a technical standard to address use of polymers with sediment control structures. While this standard is in interim form, we would advise using it as guidance in any future application of your product in Wisconsin.

If you have any questions concerning this use restriction, please feel free to contact me at (608) 261-6420.

Sincerely,

Mary Anne Lowndes

Mary Anne Lowndes
Bureau of Watershed Management

cc: Peter Kemp - DOT

www.dnr.state.wi.us
www.wisconsin.gov

Quality Natural Resources Management
Through Excellent Customer Service



CORRESPONDENCE/MEMORANDUM

DATE October 30, 2002

TO Mary Anne Lowndes, WT /2

FROM Michael Wenzholz, Wf/2

SUBJECT Use Restriction for Natural Earth Poly-Stable Plus

I am writing in response to your request to calculate a use restriction for Natural Earth Poly-Stable Plus. The use restriction is calculated below according to procedures outlined in the September 2001 draft "Guidance for Voluntary Polyacrylamide (PAM) Use in DNR Programs" document. The data used to calculate the use restriction came from toxicity tests conducted recently at the Wisconsin State Laboratory of Hygiene (letter dated 10/25/2002 from Miel Barman to Derek Hoffman of Earth & Road Corp.).

*Use Restriction Calculations*Natural Earth Poly-Stable Plus

- Manufacturer = Earth and Road Corp., Madison, Wisconsin
- Chemical Names = copolymer of Storm-Klear Gel-Floc Active Ingredient = Chitosan
- CAS # of Active Ingredient = 9012-76-4
- Whole Product Toxicological/Ecological Information:

Species	Test Duration (hours)	LC-50 (mg/l)	LC-50 ÷ 10 (mg/l)
<i>Ceriodaphnia dubia</i>	48	375	37.5
<i>Pimephales promelas</i>	96	>2000	>200

Thus the use restriction is 37.5 mg/L.

Summary

Using the data provided in the Wisconsin State Laboratory of Hygiene toxicity test report summary letter of 10/25/2002, the following use restriction was generated for Natural Earth Poly-Stable Plus:

Polymer Product	Use Restriction (mg/L)
Natural Earth Poly – Stable Plus	37.5*

* However, a note on the 10/25/2002 toxicity test summary letter states, "It should be noted that while some organisms were able to survive in the treatments, they were unable to move in all of the treatments. A microscope had to be used to determine whether or not individuals were alive (by observing their respiration). " This suggests that the EC-50 (effective concentration) would be lower and result in a lower use restriction. In Wisconsin physical and chemical impairments are

treated similarly, since the cause of death is less important than the ultimate result that death occurs. Aquatic organisms such as water fleas (e.g. *Ceriodophnio dubio*) will not survive long if they are immobile and can be considered effectively negatively impacted by the treatment, in this case the Natural Earth Poly-Stable Plus. Review of the actual toxicity test data sheets will help assess the severity of immobility observed in the test and will help detennine if the concentrations where immobility occurred were far in access of those concentrations used in field applications, thus reducing concern for the use of the product. .

Please contact me if you have any questions regarding these use restriction calculations.

Date: October 25, 2002

To: Derek Hoffman, Earth and Road

From: Miel Bannan, Wisconsin State Laboratory of Hygiene

Re: Acute test results for PAM product-NaturnJ Earth Poly-Stable Plus

Derek,

We have completed toxicity tests to generate LC50s for the product you submitted. To summarize, we tested your products using two aquatic species, the fathead minnow (*Pimephales promelas*) and a species of daphnia (*Ceriodaphnia dubia*) following USEPA toxicity testing guidelines. The daphnia test is a 48 hour test while the fathead minnow are exposed for 96 hours. Tests were conducted at 20°C in an environmental chamber with a 16:8 light:dark cycle. Daphnia less than 24 hours old were used to initiate the test and were not fed during the exposure period. Fathead minnow were 10 days old at the start of the test and were fed once after 48 hours of exposure. We renewed the test water daily. Dissolved oxygen and pH values were all within acceptable limits. LC50 values and associated ranges were calculated using Probit or Trimmed Spearman-Kärber analysis, where appropriate.

48 Hour Acute Test with *Ceriodaphnia dubia*

LC50 = 375 mg/L

95% Confidence Interval: 267- 525 mg/L

Mg/L Product	Lab Control	125	250	500	1000	2000
% Survival*	90%	70%	70%	35%	20%	0%

*It should be noted that while some organisms were able to survive in the treatments, they were unable to move in all of the treatments. A microscope had to be used to determine whether or not individuals were alive (by observing their respiration).

96 Hour Acute Test with FatHead Minnow

LC50 >2000 mg/L

Mg/L Product	Lab Control	125	250	500	1000	2000
% Survival	100%	100%	100%	100%	100%	95%